Calcul intégral — 2ème Bac Pro

Correction des exercices du polycopié du cours

EX.1 Vérifier les calculs suivants :

1°/ $\int_{-1}^{0} (2x+1)\,dx = 0$

2°/ $\int_{0}^{1} (x^3 + 6x + 1)\,dx = \frac{13}{4}$

3°/ $\int_{4}^{16} \frac{dx}{2\sqrt{x}} = 2$; 4°/ $\int_{0}^{3} \frac{dx}{x+2} = \ln\left(\frac{5}{2}\right)$

solution : 1°/ $\int_{-1}^{0} (2x+1)\,dx \overset{?}{=} 0$

on a : $\int_{-1}^{0} (2x+1)\,dx = \int_{-1}^{0} f(x)\,dx$

avec : $f(x) = 2x+1$

une primitive de f : $F(x) = x^2 + x$

car : $F'(x) = (x^2+x)' = 2x+1$

donc : $\int_{-1}^{0} (2x+1)\,dx = \int_{-1}^{0} F'(x)\,dx$

$= [F(x)]_{-1}^{0} = [x^2 + x]_{-1}^{0}$

$= 0^2 + 0 - ((-1)^2 + (-1)) = -(1-1) = \boxed{0}$

2°/ $\int_{0}^{1} (\underbrace{x^2 + 6x + 1}_{f(x)})\,dx \overset{?}{=} \frac{13}{4}$

$\Rightarrow F(x) = \frac{x^3}{3} + 6\frac{x^2}{2} + x$; F est une primitive.

donc :

$\int_{0}^{1} f(x)\,dx = [F(x)]_{0}^{1} = F(1) - F(0)$

avec : $\begin{cases} F(1) = \frac{1}{3} + \frac{6}{2} + 1 = \frac{1}{3} + 4 = \frac{13}{3} \\ F(0) = 0 + 0 + 0 = 0 \end{cases}$

donc : $\int_{0}^{1} (x^2 + 6x + 1)\,dx = \frac{13}{3}$

3°/ $\int_{4}^{16} \frac{dx}{2\sqrt{x}} = \int_{4}^{16} \underbrace{\frac{1}{2\sqrt{x}}}_{f(x)}\,dx \overset{?}{=} 2$

$f(x) = \frac{1}{2\sqrt{x}} \Rightarrow F(x) = \sqrt{x}$

donc : $\int_{4}^{16} f(x)\,dx = [\sqrt{x}]_{4}^{16} = \sqrt{16} - \sqrt{4}$

$= 4 - 2 = \boxed{2}$

4°/ $\int_{0}^{3} \frac{dx}{x+2} = \int_{0}^{3} \frac{1}{x+2}\,dx \overset{?}{=} \ln\left(\frac{5}{2}\right)$

$f(x) = \frac{1}{x+2} = \frac{(x+2)'}{x+2} = \ln'(x+2)$

$F(x) = \ln(x+2)$ donc :

$\int_{0}^{3} \frac{dx}{x+2} = F(x)]_{0}^{3} = [\ln(x+2)]_{0}^{3}$

$= \ln(3+2) - \ln(0+2) = \ln 5 - \ln 2$

$= \boxed{\ln\left(\frac{5}{2}\right)}$

EX.2 Montrer que :

1°/ $\int_{0}^{\pi} \left(4x + \frac{2}{3}\sin(x)\right) dx = 2\pi^2 + \frac{4}{3}$

2°/ $\int_{0}^{1} (5x^3 + e^x)\,dx = e + \frac{1}{4}$

3°/ $\int_{1}^{e} \left(\frac{1}{x} - \frac{1}{x^2}\right) dx = \frac{1}{e}$

4°/ $\int_{1}^{2} (2x+3)(x^2+3x)^2\,dx = 312$

Solution : 1°/ $\int_{0}^{\pi} \left(4x + \frac{2}{3}\sin(x)\right) dx$

$= 4 \times \int_{0}^{\pi} x\,dx + \frac{2}{3}\int_{0}^{\pi} \sin(x)\,dx$

$= 4\left[\frac{x^2}{2}\right]_{0}^{\pi} + \frac{2}{3}[-\cos(x)]_{0}^{\pi}$

$= 4\left[\frac{\pi^2}{2} - 0\right] + \frac{2}{3}[-(-1) + 1]$

$= 4 \times \frac{\pi^2}{2} + \frac{2}{3} \times 2 = \boxed{2\pi^2 + \frac{4}{3}}$

2°/ $\int_{0}^{1} (5x^3 + e^x)\,dx = 5 \times \int_{0}^{1} x^3\,dx + \int_{0}^{1} e^x\,dx$

$= 5\left[\frac{x^4}{4}\right]_{0}^{1} + [e^x]_{0}^{1} = 5 \times \left(\frac{1}{4} - 0\right) + e^1 - e^0$

$$\int_0^1 (5x^3+e^x)dx = \frac{5}{4}+e-1$$
$$= e+\frac{5}{4}-1 = e+\frac{1}{4}$$

3°/ $\int_1^e \frac{1}{x}-\frac{1}{x^2}\,dx = \int_1^e \frac{1}{x}dx + \int_1^e \frac{-1}{x^2}dx$

$$= \left[\ln(x)\right]_1^e + \left[\frac{1}{x}\right]_1^e$$
$$= \ln(e)-\ln(1)+\frac{1}{e}-\frac{1}{1}$$
$$= 1-0+\frac{1}{e}-1 = \boxed{\frac{1}{e}}$$

car: $\ln'(x)=\frac{1}{x}$ et $\left(\frac{1}{x}\right)' = -\frac{1}{x^2}$

donc: $\frac{1}{x}-\frac{1}{x^2} = \left(\ln(x)+\frac{1}{x}\right)'$

4°/ $\int_1^2 \underbrace{(2x+3)\,(x^2+3x)^2}_{f(x)}\,dx$

$f(x) = (x^2+3x)'(x^2+3x)^2$
$$= \frac{1}{3}\times\left[3\,(x^2+3x)'(x^2+3x)^2\right]$$
$= \frac{1}{3}F'(x)$; avec: $F(x) = (x^2+3x)^3$

donc: $\int_1^2 f(x)dx = \frac{1}{3}\left[F(x)\right]_1^2 = \frac{1}{3}(F(2)-F(1))$

$$\begin{cases} F(2) = (2^2+3\times2)^3 = (4+6)^3 = 1000 \\ F(1) = (1+3)^3 = 4^3 = 64 \end{cases}$$

$$\int_1^2 f(x)dx = \frac{1}{3}\left[1000-64\right] = \frac{936}{3} = \boxed{312}$$

EX.3 Montrer que :

1°/ $\int_0^3 2x\,e^{x^2}dx = e^9-1$

2°/ $\int_1^2 \sqrt{x}\,dx = \frac{4\sqrt{2}}{3}-\frac{2}{3}$

3°/ $\int_1^2 \frac{2x+3}{x^2+3x}\,dx = \ln\left(\frac{5}{2}\right)$

Solution: 1°/ $\int_0^3 2x\,e^{x^2}dx$

$f(x) = (x^2)'e^{x^2} = \left(e^{x^2}\right)' = F'(x)$

avec: $F(x) = e^{x^2}$ donc:

$$\int_0^3 f(x)dx = \left[F(x)\right]_0^3 = F(3)-F(0)$$
$$= e^{3^2}-e^{0^2} = e^9-e^0 = \boxed{e^9-1}$$

2°/ $\int_1^2 \sqrt{x}\,dx = \int_1^2 x^{1/2}\,dx$

$$= \left[\frac{x^{\frac{1}{2}+1}}{\frac{1}{2}+1}\right]_1^2 = \left[\frac{x^{\frac{1}{2}+1}}{3/2}\right]_1^2$$
$$= \frac{2^{\frac{1}{2}+1}}{3/2}-\frac{1}{3/2} = \frac{2^{1/2}\times2^1}{3/2}-\frac{2}{3}$$
$$= \sqrt{2}\times2\times\frac{2}{3}-\frac{2}{3} = \boxed{\frac{4}{3}\sqrt{2}-\frac{2}{3}}$$

3°/ $\int_1^2 \frac{2x+3}{x^2+3x}\,dx = \int_1^2 \frac{(x^2+3x)'}{x^2+3x}dx$

$$= \int_1^2 \ln'(x^2+3x)\,dx = \left[\ln(x^2+3x)\right]_1^2$$
$$= \ln(2^2+3\times2)-\ln(1+3\times1)$$
$$= \ln(10)-\ln(4) = \ln\left(\frac{10}{4}\right) = \boxed{\ln\left(\frac{5}{2}\right)}$$

EX.4 A l'aide d'une intégrale par partie montrer que :

1°/ $\int_{-1}^2 x e^x\,dx = 0$

2°/ $\int_0^\pi x\sin(x)\,dx = \pi$

3°/ $\int_2^e 4x^3\ln(x)\,dx = 3\frac{e^4}{4}-16\ln(2)+4$

Solution:

1°/ $\int_{-1}^2 xe^x dx = \int_{-1}^2 u(x)\,v'(x)\,dx$

avec: $\begin{cases} u(x)=x \\ v'(x)=e^x \end{cases}$ donc: $\begin{cases} u'(x)=1 \\ v(x)=e^x \end{cases}$

par suite : $\int u(x)v'(x)\,dx = [u(x)v(x)] - \int u'(x)v(x)\,dx$

$\Rightarrow \int_{-1}^{2} xe^{x}\,dx = [1\times e^{x}]_{-1}^{2} - \int_{-1}^{2} 1\times e^{x}\,dx$

$= e^{2} - e^{-1} - \int_{-1}^{2} e^{x}\,dx$

$= e^{2} - e^{-1} - [e^{x}]_{-1}^{2} = e^{2} - e^{-1} - (e^{2} - e^{-1})$

$= e^{2} - e^{-1} - e^{2} + e^{-1} = \boxed{0}$

2°/ $\int_0^{\pi} x\sin(x)\,dx = \int_0^{\pi} \underbrace{x}_{u(x)} \times \underbrace{\sin(x)}_{v'(x)}\,dx$

$\begin{cases} u(x) = x \\ v'(x) = \sin(x) \end{cases} \Rightarrow \begin{cases} u'(x) = 1 \\ v(x) = -\cos(x) \end{cases}$

donc

$\int u(x)\,v'(x)\,dx = [u(x)v(x)] - \int u'(x)v(x)\,dx$

$\int_0^{\pi} x\sin(x)\,dx = [-x\cos(x)]_0^{\pi} - \int_0^{\pi} 1\times(-\cos(x))\,dx$

$= [-\pi(-1) + 0] + \int_0^{\pi} \cos(x)\,dx$

$= \pi + [\sin(x)]_0^{\pi} = \pi + (0-0) = \boxed{\pi}$

3°/ $\int_2^{e} 4x^3\ln(x)\,dx = \int_2^{e} (4x^3)\,\ln(x)\,dx$

$\begin{cases} u'(x) = 4x^3 \\ v(x) = \ln(x) \end{cases} \Rightarrow \begin{cases} u(x) = x^4 \\ v'(x) = \frac{1}{x} \end{cases}$

$\int_2^{e} 4x^3\ln(x)\,dx = [u(x)v(x)]_2^{e} - \int_2^{e} u(x)v'(x)\,dx$

$= [x^4\ln(x)]_2^{e} - \int_2^{e} x^4 \times \frac{1}{x}\,dx$

$= e^4\ln(e) - 2^4\ln(2) - \int_2^{e} x^3\,dx$

$= e^4 \times 1 - 16\ln(2) - \left[\frac{x^4}{4}\right]_2^{e}$

$= e^4 - 16\ln(2) - \left(\frac{e^4}{4} - \frac{2^4}{4}\right)$

$= e^4 - \frac{e^4}{4} - 16\ln(2) + \frac{16}{4}$

$= \left(1 - \frac{1}{4}\right)e^4 - 16\ln(2) + 4$

$= \boxed{\frac{3}{4}e^4 - 16\ln(2) + 4}$